Physics 129A: Particle Physics
(Freedman)
Fall '04
Problem Set # 9
November 25, 3004
Due Wednesday December 1, 2004
(By popular demand there are only three problems.)
Happy Thanksgiving

1. (Problem 5.1 Perkins) Show that an exponential charge distribution in the proton of the form $\rho(R) = \rho(0)\exp(-M_V R)$ leads to a dipole form factor of the form:

$$F(q^2) \cong \frac{1}{(1+q^2/M_V^2)^2} \ .$$

and that a value $M_V = 0.84 GeV$ leads to a rms radius of the charge distribution of the proton of 0.8 fm. Show also that for the quasi-elastic process $\nu_\mu + n \rightarrow \mu^- + p$, the total cross section tends to a constant as $E_\nu \rightarrow \infty$. (see Perkins page 168 for a hint)

2. (Problem 5.5 Perkins) A neutrino of energy E_0 and negligible mass collides with a stationary electron. Find an expression for the laboratory angle of emission of the electron in terms of the recoil energy E and calculate its value when E_0=1 GeV and E=0.5 GeV. Calculate the maximum momentum transfer to the electron when E_0=1 GeV ($m_e c^2$ = 0.51 MeV)

3. (Problem 5.10 Perkins) Express the variables x and y defined in Perkins (5.50) and (5.15) in relativistically invariant form. Show that

$$x = -\frac{q^2}{2Pq}$$

$$y = -\frac{2Pq}{s}$$

where the 4-momenta P and q are defined in Perkins Fig. 5.12 and s is the squared total cms energy in the collision.